PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference FP20790	**FOR FURTHER ACTION**	See Form PCT/IPEA/416
International application No. **PCT**/AU2004/001686	International filing date *(day/month/year)* 1 December 2004	Priority date *(day/month/year)* 5 December 2003

International Patent Classification (IPC) or national classification and IPC

Int. Cl. ***H05K 3/06*** (2006.01) ***C23F 1/02*** (2006.01)

Applicant

THE COMMONWEALTH OF AUSTRALIA et al

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 3 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. [X] *(sent to the applicant and to the International Bureau)* a total of **9** sheets, as follows:
      - [X] sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      - [ ] sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.

   b. [ ] *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or table related thereto, in electronic form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).
4. This report contains indications relating to the following items:

[X]	Box No. I	Basis of the report
[ ]	Box No. II	Priority
[ ]	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
[ ]	Box No. IV	Lack of unity of invention
[X]	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
[ ]	Box No. VI	Certain documents cited
[ ]	Box No. VII	Certain defects in the international application
[ ]	Box No. VIII	Certain observations on the international application

Date of submission of the demand	Date of completion of this report
5 July 2005	01 January 2006
Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized Officer **N. STOJADINOVIC** Telephone No. (02) 6283 2124

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/AU2004/001686

Box No. I Basis of the report

1. With regard to the **language**, this report is based on:

[X] The international application in the language in which it was filed

[ ] A translation of the international application into , which is the language of a translation furnished for the purposes of:

- [ ] international search (under Rules 12.3(a) and 23.1 (b))
- [ ] publication of the international application (under Rule 12.4(a))
- [ ] international preliminary examination (Rules 55.2(a) and/or 55.3(a))

2. With regard to the **elements** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

[ ] the international application as originally filed/furnished

[X] the description:

pages **1,3,5-10,12-14** as originally filed/furnished
pages* **2,4,11** received by this Authority on **5 July 2005** with the letter of **5 July 2005**
pages* received by this Authority on with the letter of

[X] the claims:

pages as originally filed/furnished
pages* as amended (together with any statement) under Article 19
pages* **15-20** received by this Authority on **5 July 2005** with the letter of **5 July 2005**
pages* received by this Authority on with the letter of

[X] the drawings:

pages **1,2** as originally filed/furnished
pages* received by this Authority on with the letter of
pages* received by this Authority on with the letter of

[ ] a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing.

3. [ ] The amendments have resulted in the cancellation of:

- [ ] the description, pages
- [ ] the claims, Nos.
- [ ] the drawings, sheets/figs
- [ ] the sequence listing *(specify)*:
- [ ] any table(s) related to the sequence listing *(specify)*:

4. [ ] This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

- [ ] the description, pages
- [ ] the claims, Nos.
- [ ] the drawings, sheets/figs
- [ ] the sequence listing *(specify)*:
- [ ] any table(s) related to the sequence listing *(specify)*:

* *If item 4 applies, some or all of those sheets may be marked "superseded."*

Box No. V **Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims **1-43**	**YES**
	Claims	**NO**
Inventive step (IS)	Claims **1-43**	**YES**
	Claims	**NO**
Industrial applicability (IA)	Claims **1-43**	**YES**
	Claims	**NO**

2. Citations and explanations (Rule 70.7)

Novelty (N) Inventive Step (IS) Claims 1-43

- WO 1997/019580
- US 4081653
- US 4649497
- US 6100178

All of the above disclose a method of manufacturing an electrical component where a thin metal foil is bonded to an insulating substrate and a laser is used to machine at least one trench at least equal in depth to the thickness of the foil.

US 6100178 is of special relevance as it teaches a 3 dimensional PCB created by ablation or etching of the conducting layer followed by filling of the trenches with a dielectric, in the general course of over coating them to form a subsequent layer.

None of the documents however disclose the filling of the trenches with a trench filling material without overlaying the metal face with said material and this it considered to confer novelty over the cited art. The claims thus meet the requirements of novelty and inventive step.

SUMMARY OF THE INVENTION

According to the present invention, there is provided a method of manufacturing an electrical component, involving:

bonding a thin metal foil to an insulating substrate and thereby forming a component blank having a metal face that comprises a surface of said metal foil;

laser machining at least the metal foil of said component blank to produce at least one trench for defining one or more foil tracks, said trench being at least equal in depth to the thickness of the foil so as to prevent current flow across the trench; and

filling said trench with a trench filling material without overlaying said metal face with said trench filling material.

Preferably the insulating material is a polymer.

Preferably said polymer comprises an epoxy resin, such as EPOTHIN (TM) brand epoxy resin.

The method preferably includes forming said metal foil from a parent foil that is substantially identical with the material of the structure to be monitored.

The method may also include laser machining said component blank to produce one or more back slots, said slots being equal in depth to the full thickness of said sensor. The back slots can then be used for the purpose of filling the trenches with a trench filling material, e.g. an insulating material.

The method preferably includes preparing the metal foil by machining a sample of parent material to a desired final thickness. More preferably the method includes alternately machining both faces of the parent material until said final thickness is achieved.

Preferably said laser machining said foil comprises producing slots, in one embodiment of approximately 150 µm length at 1.5 mm intervals. Preferably a polymer is introduced into the trenches preferably using the slots.

The invention also provides an electrical component produced according to the above method.

The invention still further provides an electrical component, comprising: an insulating substrate; a thin metal foil bonded to said insulating substrate; a metal face comprising a surface of said thin metal foil; and at least one laser machined trench for defining one or more foil tracks so as to prevent current flow across the trench, said trench being at least equal in depth to the thickness of the foil; wherein said trench is filled with a trench filling material that does not overlay said metal face.

Electrical components that can be made using this method include, for example, linear polarisation resistance gauges, electrochemical impedance spectrometry gauges, corrosion resistance gauges, spiral inductors and delay circuits.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that the invention may be more clearly ascertained, an embodiment will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a diagram of the three laser path files used in the laser machining of a pair of sensors according to an embodiment of the present invention;

Figure 2A is a further diagram of the setup file pattern of figure 1;

Figure 2B is a further diagram of the sensor cutting file pattern of figure 1; and

Figure 2C is a further diagram of the sensor back

aluminium alloy structure can be correlated with a corrosion sensor made of precisely the same material.

Such foils sensors can be made with fine feature size. The ability to machine stable structures in the tens of microns range enables electrical parameters to be scaled to a point where they can be reliably measured.

Methods such as described above are suitable for manufacturing electronic components where the thin metal foil is in the range of 15 to 200 μm in thickness, although. It will be appreciated that thicker metal foils could be used but as a result the cutting process becomes more difficult and higher power lasers may be required. The typical minimum spacing between the electrodes (i.e. metal tracks) is the cutting width of the laser beam which in this example is 25 to 30 μm. This closer separation of electrodes (i.e. the trench width) allows sensors of higher sensitivity to be produced, though it will be appreciated that, depending on the application, wider trenches may be suitable, for example to adjust the sensitivity of a device.

Metal foil sensors produced according to the method have a closer spacing of elements in the sensors because they are produced using laser machining rather than a chemical etching process. Further, this allows sensor fabrication to be largely independent of the metal that the sensor is being fabricated in unlike a chemical process. Resistance sensors of superior sensitivity due to the higher resistance obtained using long, thin, compact serpentine patterns can be produced. Further, flat inductive devices and sensors will have a lower resistance and higher inductance than similar sized devices produced using etching process.

The ratio of depth of the trench to width of the trench

CLAIMS:

1. A method of manufacturing an electrical component, involving:

bonding a thin metal foil to an insulating substrate and thereby forming a component blank having a metal face that comprises a surface of said metal foil;

laser machining at least the metal foil of said component blank to produce at least one trench for defining one or more foil tracks, said trench being at least equal in depth to the thickness of the foil so as to prevent current flow across the trench; and

filling said trench with a trench filling material without overlaying said metal face with said trench filling material.

2. A method as claimed in claim 1, including performing said laser machining by means of a laser with a cutting width, and creating foil tracks with a spacing approximately equal to said cutting width.

3. A method as claimed in claim 1, wherein said cutting width is from 25 to 30 μm.

4. A method as claimed in claim 1, wherein said trench filling material is an insulating material.

5. A method as claimed in claim 3, wherein said insulating material is a polymer.

6. A method as claimed in claim 5, wherein said polymer comprises an epoxy resin.

7. A method as claimed in claim 1, wherein said trench filling material is a dielectric material and said electric component is a sensor that responds to changes in said dielectric material.

8. A method as claimed in claim 1, wherein said electrical component is a foil sensor, and said method further comprises forming said metal foil from a parent foil that is substantially identical with the material of the structure to be monitored.

9. A method as claimed in claim 1, further comprising laser machining said component blank to produce one or more back slots, said back slots being equal in depth to the full thickness of said component blank.

10. A method as claimed in claim 9, wherein laser machining said component blank comprises producing slots of approximately 150 μm length at 1.5 mm intervals.

11. A method as claimed in claim 9, further comprising introducing a trench filling material into said trenches via said back slots.

12. A method as claimed in claim 1, further comprising preparing the metal foil by machining a sample of parent material to a desired final thickness.

13. A method as claimed in claim 12, comprising alternately machining both faces of the parent material until said final thickness is achieved.

14. A method as claimed in claim 1, further comprising preparing the metal foil for said bonding by applying a chemically resistant film to a first face of said foil, and applying a bond enhancer to the other face of said foil, wherein said first face is ultimately the exposed face and said chemically resistant film protects said first face from said bond enhancer.

15. A method as claimed in claim 14, comprising

drying said foil and then removing said film.

16. A method as claimed in claim 14, wherein said chemically resistant film comprises a polyester tape.

17. A method as claimed in claim 1, wherein said insulating material is chosen to have an ablation rate that is sufficiently low to prevent unwanted penetration of the substrate during machining to remove said foil.

18. A method as claimed in claim 17, wherein said insulating substrate comprises a plurality of layers of fibreglass prepreg.

19. A method as claimed in claim 1, wherein said electrical component is a foil sensor, the method comprises preparing said component blank by coating said component blank on the surface comprising the ultimate sensor side of said sensor blank with a chemically resistant coating solution, to protect said surface from contamination during sensor processing.

20. A method as claimed in claim 19, comprising drying said sensor blank after coating said sensor blank.

21. A method as claimed in claim 1, comprising laser machining said blank to form two different types of sensors.

22. A method as claimed in claim 1, wherein said electrical component is selected from the group of:

a linear polarisation resistance gauge;
a corrosion sensor;
a resistance sensor;
a non-destructive testing sensor;
a spiral inductor;
a delay line;

a capacitor; and

a sensor responsive to changes in a dielectric material.

23. A method as claimed in claim 1, including producing said trench with a ratio of depth to width of from 1:1 to 7:1.

24. A method as claimed in claim 1, including forming said trench with side walls that are substantially straight.

25. An electrical component produced according to the method of any one of claims 1 to 24.

26. A foil sensor produced according to the method of claim 25.

27. An electrical component, comprising:

an insulating substrate;

a thin metal foil bonded to said insulating substrate;

a metal face comprising a surface of said thin metal foil; and

at least one laser machined trench for defining one or more foil tracks so as to prevent current flow across the trench, said trench being at least equal in depth to the thickness of the foil;

wherein said trench is filled with a trench filling material that does not overlay said metal face.

28. An electrical component as claimed in claim 27, wherein said trench is laser machined by means of a laser with a cutting width, and said foil tracks have a spacing approximately equal to said cutting width.

29. An electrical component as claimed in claim 27,

wherein said cutting width is from 25 to 30 μm.

30. An electrical component as claimed in claim 1, wherein said trench filling material is an insulating material.

31. An electrical component as claimed in claim 30, wherein said insulating material is a polymer.

32. An electrical component as claimed in claim 31, wherein said polymer comprises an epoxy resin.

33. An electrical component as claimed in claim 27 wherein said trench filling material is a dielectric material.

34. An electrical component as claimed in claim 27, wherein said electrical component comprises at least one of:

a linear polarisation resistance gauge;
a corrosion sensor;
a resistance sensor;
a non-destructive testing sensor;
a spiral inductor;
a delay line;
a capacitor; and
a sensor responsive to changes in a dielectric material.

35. An electrical component as claimed in claim 27, wherein said electrical component comprises two or more different types of foil sensors.

36. An electrical component as claimed in claim 27, wherein the metal foil has a thickness in the range of 15 to 200 μm.

37. An electrical component as claimed in claim 28, wherein said trench has a ratio of depth to width of from 1:1 to 7:1.

38. An electrical component as claimed in claim 27, wherein said trench has side walls that are substantially straight.

39. An electrical component as claimed in claim 27, wherein said substrate is formed of a material having a sufficiently low rate of ablation to prevent unwanted penetration of the substrate during machining.

40. An electrical component as claimed in claim 39, wherein said substrate comprises a plurality of layers of fibreglass prepreg.

41. An electrical component as claimed in claim 27, wherein said electrical component is a foil sensor and said metal foil from a parent foil that is substantially identical with the material of the structure to be monitored.

42. An electrical component as claimed in claim 27, comprising one or more back slots, said slots being equal in depth to the combined thickness of said foil and said substrate.

43. An electrical component as claimed in claim 42, wherein said slots are approximately 150 μm length at 1.5 mm intervals.